Innovation and Appropriability: Revisiting the Role of Intellectual Property

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Abstract

It is more than 25 years since the authors of the Yale and Carnegie surveys studied how firms seek to protect the rents from innovation. In this paper, we revisit that question using a nationally representative sample of firms over the period 2008-2015, with the goal of updating and extending a set of stylized facts that has been influential for our understanding of the economics of innovation. There are five main findings. First, while patenting firms are relatively uncommon in the economy, they account for an overwhelming share of R&D spending. Second, utility patents are considered less important than other forms of IP protection, like trade secrets, trademarks, and copyrights. Third, industry differences explain a great deal of the level of firms' engagement with IP, with high-tech firms on average being more active on all forms of IP. Fourth, we do not find any significant difference in the use of IP strategies across firms at different points of their life cycle. Lastly, unlike age, firms of different size appear to manage IP significantly differently. On average, larger firms tend to engage much more extensively in the protection of IP, and this pattern cannot be easily explained by differences in the type of R&D or innovation produced by a firm. We also discuss the implications of these findings for innovation research and policy.

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1 Introduction

Economists generally view innovation as the most significant driver of long-run productivity growth, and knowledge spillovers as main reason why the social returns exceed the private returns to R&D. At the firm level, however, our understanding of the relationship between intellectual property (IP) protection, R&D investment, and innovation outcomes has long been hampered by measurement problems and a lack of data. In particular, although a large literature uses patents to measure innovation outcomes, relatively few studies consider the decision to patent, or how that decision interacts with other business characteristics.

Two notable exceptions to this gap in our knowledge about private innovation incentives are the Yale and Carnegie surveys, conducted by Levin et al (1987) and Cohen et al (2000), which asked R&D managers about their firms' strategies for appropriating the value of their innovations. Yet these surveys are now more than 20 years old, and evidence has started to accumulate suggesting that the locus of R&D investment and innovation for U.S. firms has changed during this period (Foster, Grim and Zolas 2020; Ozcan and Greenstein 2013).[1] Furthermore, for practical reasons the Yale and Carnegie surveys focused on large firms in manufacturing industries, leaving us with relatively little knowledge about the incidence of R&D or the importance of intellectual property in smaller companies and other sectors.

We revisit the broad question of how firms appropriate the benefits of innovation using survey data collected by the US Census data between 2008 and 2015. Our results suggest that many patterns uncovered in previous literature have persisted. For example, most US firms indicate that trade secrecy is the most important tool for protecting an innovation. The perceived importance (and actual use) of utility patents and other types of formal intellectual property protection varies greatly across industries.

Our analysis also generates some new stylized facts about IP and innovation. For example, although a majority of US firms that perform R&D do not patent, it is patenting firms that perform

[1] In addition to these surveys, Nicholas (2011) matched data on R&D performing firms from a pair of surveys conducted by the National Research Council in 1921 and 1938 to historic patent records. Nicholas' results suggests that pre-war R&D performers were more likely to use the patent system than those surveyed at the time of the surveys by Levin et al (1987) and Cohen et al (2000). This evidence may in part reflect the larger importance of innovation conducted by independent inventors before the Great Depression (Babina, Bernstein, and Mezzanotti, 2021).

the vast majority of reported R&D. Perhaps surprisingly, firm age is not strongly correlated with the importance of various forms of IP. Firm size, on the other hand, is an important predictor. Larger firms are significantly more interested in all forms of IP protections, and we show that a firm's size is in general one of the most important determinants of its use of patents and other types of protection. This size effect cannot be easily explained by other differences in the quality or intensity of R&D inputs, type of innovative output, or a firm's strategy in the use of IP. Altogether, the survey evidence highlights disparate use of intellectual property protection by the broad cross-section of US firms.

Our data come from the Business R&D and Innovation Survey (BRDIS). This survey is conducted annually by the Census Bureau in collaboration with the National Science Foundation's National Center for Science and Engineering Statistics, and aims to provide a representative outlook of R&D activity conducted by for-profit, nonfarm businesses with five or more employees operating in the United States. As a result, the survey targets a sample of more than 40 thousand firms a year and asks questions about R&D activity, their use of intellectual property, and other demographic information.

Three features of the BRDIS data are particularly important for our analysis. First, unlike the earlier Yale and Carnegie surveys, BRDIS covers a large representative sample of firms. This allows us to compare the use of IP across firms of different size, age, and industry, encompassing firms that are both active and inactive in R&D, and to produce estimates that are representative of the population of US firms. Second, the survey combines quantitative measures on IP (e.g. patent counts) with qualitative variables that report the importance of different forms of IP protection strategies by a company. The qualitative measures facilitate comparison of preferences across different firms and allow us to explore business practices (e.g. trade secrets) that are intrinsically hard to observe and quantify. To address concerns related to the presence of biases in reporting these qualitative assessments, we show that self-reported preference measures line up well with firms' actual behavior. And third, because BRDIS is an annual survey, we can use it to construct panel data.

The paper is organized around five stylized facts that we introduce here, and discuss in detail below. First, patenting firms are relatively rare in the US economy. Only around 25% of the companies in our sample are patenting firms according to our definition. But this set of companies is particularly important because they perform an overwhelming share of US R&D investment. Second, we show that patents are generally not considered the most important tool for appropriating the benefits of an innovation. In absolute terms, around two-thirds of the firms report that utility patents are not important at all.[2] In relative terms, patents are generally considered significantly less important than trade secrets, as well as copyrights and trademarks.

Third, we show that IP strategies vary substantially across different industries. Companies that operate in the high-tech sector consistently report that all forms of IP protection are more important. In general, the relative importance of different types of IP does not vary significantly by industry (with the outsized importance of patents to Life Science firms a notable exception). Outside of high-tech, manufacturing, and retail, however, the importance of IP is extremely low. For example, almost 90% of firms from outside those three sectors report that patents are not at all important.

Fourth, we examine how the importance of IP changes over the life cycle of a firm, comparing survey responses and actual behavior across different age cohorts. Surprisingly, we do not find any systematic relationship between firm age and our measures of IP strategy. This result is robust to controlling for industry effects, firm size, R&D intensity, and other factors. This finding suggests that IP policy might be modeled as a state-variable that is determined ex-ante, in expectation of how a firm plans to operate in the future. As a result, this feature does not systematically change over time. Consistent with this idea, we show that early decisions of a firm regarding R&D and patenting strongly predict future growth, as in Guzman and Stern (2020).

Fifth, we find that firm size is an important determinant of IP policies. Larger firms consider all types of formal IP – patents, trade secrets, copyrights, and trademarks – to be more important. This relationship is monotonic and economically significant. For instance, a firm in the largest size bucket considers patents three times more important than those in the smaller bucket. Moreover, the relationship between firm size and patenting is not easily explained by differences in other observable characteristics. In particular, we find similar results when we control for industry, age, R&D investment, innovation output, expertise in the market for technology, and the use of other types of IP. In fact, the effect of size is so dominant, that it partially trumps some of differences

[2] This number for design patents is even higher, as discussed in the paper.

across industries. For instance, among relatively large firms (i.e. above $100 M in worldwide sales) the gap between firms in life-science, IT, retail and manufacturing substantially shrinks relative to the whole population.

We contribute to a literature that uses survey evidence to study how firms utilize IP, and more generally, protect the profits generated through innovation. Sampat (2018) provides reviews this literature which, in addition to the Yale and Carnegie surveys discussed above, includes pioneering work by Scherer (1959) and Mansfield (1986), as well as the more recent Berkeley Patent Survey (Graham et al 2009) focusing on small early-stage companies. Although we address similar questions as prior work, we extend the analysis in a number of directions by combining observational with qualitative response data, and by relying on a representative sample of all US firms, as opposed to just manufacturing firms or those with R&D laboratories.

We also contribute to a more recent literature that seeks to disentangle the role of age and size in firm dynamics and economic growth. Haltiwanger, Jarmin and Miranda (2013) launched this stream of research by highlighting the importance of young (as opposed to small) firms for job creation. Interesting, we find that it is size, rather than age, that explains firms' reliance on patents and formal IP. At the same time, for a sample of newly established firms, we show that patenting is strongly correlated with employment growth – a result that echoes recent findings of Guzman and Stern (2020).

Finally, this paper contributes to a broader literature on the determinants of innovation activity.[3] Because the older survey evidence is often cited by academics and policymakers, it is important to check whether the received wisdom still holds regarding the relative importance of different type of IP protection. Our finding that firm size plays an important role in formal IP use may also be relevant for the literature in productivity concerned with the role of intangible capital in

[3] To cite some of the papers in this large and growing literature, scholars have examined how innovation is affected by immigration (e.g., Kerr and Lincoln, 2010; Moser et al., 2014), taxation (e.g., Akcigit et al. 2017), intellectual property laws and enforcement (e.g., Moser, 2005; Mezzanotti, 2021, Mezzanotti and Simcoe, 2019), government investments in R&D (e.g., Gross and Sampat, 2020; Moretti et al., 2019), the relationship with basic scientific knowledge (Arora et al, 2018; Arora et al, 2021), bank credit (e.g., Bai et al., 2018; Huber, 2018), competition (e.g., Aghion et al., 2005), boundaries of the firm (e.g., Seru, 2014; Frésard et al., 2020), and early-life experiences (e.g., Bell et al., 2019), among other things.

explaining the increase in concentration and low investment by US firms (Crouzet and Eberly, 2019).

2 Data

2.1 The Business R&D and Innovation Survey

Our data come primarily from the Business R&D and Innovation Survey (BRDIS). This survey was the successor of the Survey of Industrial Research and Development (SIRD), and it was organized in partnership between Census Bureau and the National Science Foundation's National Center for Science and Engineering Statistics.[4] The survey was conducted annually from 2008 until 2016 and aimed to provide a representative outlook of R&D activity conducted by for-profit, nonfarm businesses with five or more employees operating in the United States. As a result, the survey targets a sample of more than 40 thousand firms a year and covers variety of questions regarding the R&D activity of the company surveyed, their use of intellectual property, and other demographic information. For the period covered by our study, BRDIS is one of the main inputs used for the construction of aggregate statistics on R&D in US. However, the use of this data at disaggregated level remains limited (Driver, Kolasinski, and Stanfield, 2020; Foster, Grim and Zolas 2020).[5]

This BRDIS data has two key features that are important for this study. First, it covers a large and representative sample of firms, thereby allowing us to compare innovation and the use of intellectual property (IP) across a wide variety of firms in a consistent manner. Thanks to this data, we can study differences in behavior across companies of different size, age, and industry, encompassing firms that are both active and inactive in R&D. The representativeness of the sample gives us a crucial advantage relative to the past literature, which had to rely on smaller surveys

[4] BRDIS has been deprecated in 2016. More information on the survey can be obtained on the website of the NSF: https://www.nsf.gov/statistics/srvyberd/prior-descriptions/overview-brdis.cfm

[5] In particular, Foster, Grim and Zolas (2020) uses BRDIS combined with SIRD to understand how the type of firms investing in R&D has changed between 1992 and 2011, while Driver, Kolasinski, and Stanfield (2020) uses BRDIS to compare how public versus private firms differ in the type of research they conduct (i.e. research versus development).

generally focused on large firms active in R&D intensive industries (e.g. Levin, Klevorick, Nelson and Winter, 1987; Cohen, Nelson and Walsh, 2000).[6]

Second, the sample allows us to consistently measure innovative activity across firms. On top of information on the innovation inputs and outputs, the survey also asks firms to rate the importance of several forms of IP protections: utility patents, design patents, trade secrets, copyrights, and trademarks.[7] Specifically, firms are asked to rate each of these strategies as very important, somewhat important, or not important.[8] This qualitative assessment has the advantage of facilitating the comparison of preferences across different firms and strategies. In fact, this measure does not require us to make any adjustments to account for differences in firms' scale or scope of the operation, as we would do for actual behavior.[9] Furthermore, since every firm is asked this question, we can use these variables to measure the underlying preferences of firms without having to condition on actual behavior. Lastly, it allows us to also examine dimensions (e.g. trade secrets) that are generally difficult to measure in the data. However, one concern with this data is whether firms truthfully report their preferences. As we discuss below, we address this issue by showing that preference strongly correlates with actual behavior.

We construct our sample by combining the eight waves of the survey between 2008 and 2015. From this version of the data, we then exclude non-respondent firms as well as foreign-owned firms.[10] We also work extensively on making the survey variables comparable across the sample period.[11] While most of the core variables are asked across all the survey years, the exact way a

[6] This is also an advantage relative to Graham et al. (2009), which surveys a sample of high-tech startups in the biotechnology, medical device, IT hardware, software, and Internet sectors.

[7] The survey also asks about mask works. We exclude this measure from our study because the relatively small numbers of firms involved with this strategy may create concerns with disclosure.

[8] These questions are generally contained in the "Intellectual Property" Section. For instance, in 2009 the question asked "During 2009, how important to your company were the following types of intellectual property protection?"

[9] For instance, even if we had actual data on the behavior of a firm in trade secrets, patents, and copyrights, it would be difficult to compare the importance of the three activities between each other.

[10] We identify foreign-owned firms as firms with a foreign majority ownership using the flag reported in the Standard Statistical Establishment Listing (SEEL). The key issue with foreign-owned firms is that they are asked to report information on activity conducted within the US, therefore excluding substantial R&D operation conducted abroad. Instead

[11] One minor problem with the survey is that in some cases multiple establishments within the same firm are surveyed in the same year. We keep the data at firm level using the following process. First, if there are multiple establishments within the same firm, we notice that in most cases only one actually responds to the survey. As a result, as first step, we drop all non-respondents when at least one firm has responded to the main questions (i.e. sales, R&D spending, IP,…). Second, for the very few cases that are left after step 1, we keep the establishment

measure is reported may differ across the different waves. To facilitate the disclosure process and keep a sample that is more constant across analyses, we then construct a final sample by only keeping those firms that consistently report all variables used in the study.

While the underlying BRDIS data comprises a large cross-section of firms, those known to perform R&D are over-sampled. We retain longitudinal firm-level links when available, and use them in some of our analyses. We also match our sample with the Longitudinal Business Database (LBD), which provides more detailed information on firm age, as well as longitudinal data on employment. Finally, we match the cleaned BRDIS dataset with administrative data on granted US patents via the matching procedure developed by Dreisigmeyer et al. (2018). While the survey contains information on patenting in the year of the survey, matching the full patent data set allows us to also observe patenting also in years that are different from the survey years. To facilitate the presentation of the results, we will introduce the specific variable construction in the text as these new variables are presented.

2.2 Validating the Measure of IP Importance

Before turning to the main analysis, we address one of the main concerns with the self-reported measures on the importance of different IP strategies: firms may not truthfully report their real preferences. To address this concern, we compare self-reported preferences with actual behavior, and show that the measures are strongly correlated. We conduct this analysis looking at patents, for which we have both types of measures.

The results of this analysis are reported in the two panels of Figure 1. Across the two panels, we examine two distinct measures of patenting behavior, which separately capture the importance of patenting at the intensive and extensive margin. In panel the left panel, our main measure of patenting behavior is a dummy variable ("Any patent") that identifies those firms that have applied to at least one patent in the five-year window around the survey year (i.e. between two year before and after). In the right panel, we employ a measure of patent intensity, which is constructed as the

reporting the highest firm's sale, under the assumption that this establishment is more likely to have the most comprehensive responses. Given the relatively small number of firms with this issue, results are almost identical if we do not do any adjustment.

number of patents applied in the five-year window around the survey relative to the amount of worldwide R&D performed in millions of dollars in the year of the survey.[12]

Across the two panels, we then plot the mean of each variable conditional on a firm's stated importance of patents. We consistently find that firms' stated preference for patenting is strongly and positively associated with their actual patenting behavior, at both the intensive and extensive margin. Firms that consider utility patents as very important are around five times more likely to have patented during the five-year period around the survey than firms that report patents are not important. By the same token, we find that firms reporting patents to be "very important" obtained more than four times as many patents per dollar of R&D performed than firms indicating that patents were not important. Importantly, the relationship between self-reported importance and behavior is monotonic.

While not surprising, these results provide some validation for the self-reported measures of IP importance that we use below. For patents at least, stated preference and observed behavior seem to line up quite clearly.

3 Intellectual Property at U.S. Firms

We now present a set of five stylized facts on how US firms use intellectual property protections.

3.1 Patenting is relatively uncommon in the economy, but most R&D is concentrated among patenting firms.

To start, we examine the joint distribution of patenting and R&D among firms in the US economy. To conduct this analysis, we use the full set of firms described in the previous Section and we categorize them across these two dimensions. We define a firm as a patenting firm if it applied at least one (later granted) US patent in the 5-year window around the survey year. We define a firm as active in R&D if it reports that performed any amount of R&D in the same year. We then split the sample in four groups, depending on the cross-tabulation between conducting R&D and patenting. This result is reported in Figure 2.

[12] These variables are the same used later in the regression analysis. The patent intensity measure is winsorized at 5% to exclude that any of our results is affected by the presence of outliers.

Just over one half of the surveyed firms (52.7%) perform R&D, and one quarter (25%) of them obtain patents. Conditional on conducting R&D, the patenting share increases to around 42 percent. In fact, we see that only 22% of all firms are both doing R&D investments and patenting, while almost 31% is doing R&D but not patenting. Overall, while a substantial share of firms uses the patent system, it is not the norm. Interestingly, there is also a non-trivial number of companies patenting without conducting R&D – about 2.2% of the overall sample, or 9.2% of the share of patenting firms.[13] This result is particularly notable given that the survey is biased towards firms active in R&D (Section 2).

While patenting firms are a minority in the economy, they nevertheless account for a large majority of R&D activity. Figure 3 reports the share of R&D performed by patenting and non-patenting firms, and shows that more than 91% of R&D is performed by firms that patent.

These results provide a first glimpse of the data on IP strategies. While only a minority of firms are actively patenting, there is a clear selection into that set of firms, which conducts most of the private US R&D activity. In the next sub-sections, we explore this selection process by examining life-cycle factors and size differences across firms.

3.2 Patenting is not the main strategy to protect IP

Our next step is to examine the importance of patenting compared to other types of IP protection. As described above, firms are asked to report a qualitative assessment of the importance of utility patents, design patents, trade secrets, copyrights, and trademark across three categories: very important, somewhat important, and not important. In Figure 4, we report the share of firms in each of the three response categories for the different IP strategies.

If we rank the various types of IP protection according to the share of respondents who indicate that they are important or very important, then trade secrecy and trademarks appear to be the most useful. The top three would be trade secrets (considered very or somewhat important by more than 52% of firms), trademarks (around 50% of firms), and copyright (slightly less than 39% of firms). Around 24 percent of U.S. companies report that utility patents are very important, and another

[13] Obviously, some of these firms may have conducted R&D in a year different than the surveyed ones. Since for most firms are in the data only once, we cannot check how common this is. However, looking at the sample of firms reporting in multiple years, we find that normally companies that do some R&D in one year, are also doing R&D in all other years.

11% report them as somewhat important. Only design patents, whose use is more concentrated to specific types of firms, are consistently reported to be less important than utility patents.

While BRDIS survey does not ask about specific types of appropriability mechanisms (e.g. lead-time advantages, manufacturing or sales and service capabilities), our finding that trade secrets are generally viewed as more important than patenting is broadly consistent with the results of the Yale and Carnegies surveys.

3.3 Importance of IP Varies with Product Market Characteristics

A natural follow-up to the prior analysis is to examine whether differences in the importance of various types of IP protection stem from differences in product market characteristics, as potentially captured by a firm's industry. We start by dividing our firms in five groups based on their industry classification within the Census. In particular, we categorized firms as Life Science and Drugs, Information Technologies (IT), other manufacturing, retail, and others (as the residual category).[14] In Figure 5, we then report the (relative) importance of the different IP strategies across industries.

Across all IP strategies, we find that industry plays an important role in explaining firms' responses. First, there is a clear "level effect" across industries, as some industries consistently care more about all forms of IP protection. In particular, high-tech industries (i.e. Life Science and IT) report that formal IP is relatively more important, while firms in the Other category consistently rank at the bottom in terms of stated importance.

Focusing on Life Science firms, we document that around 70% of them report patents to be either very or somewhat important, which is significantly higher than the value of IT (43.9%), manufacturing (36%), retail (30%), and other (11%). Almost all the other IP protections share the same ranking. For instance, if we look at trade secrets, Life Science still ranks first with 76.4% of firms reporting this strategy to be at least somewhat important, followed again by IT (66.5%), manufacturing (58.3%), retail (44.8%), and other firms (24.7%). The only notable exception is

[14] Our broad industry definition is the following. Using NAICS code as input, we define IT as 3341, 3342, 3344, 3345, 3346, 3353, 5112, 5141, 5171, 5172, 5179, 5182, 5191, 5413, 5414, 5415, 5416, 5142, 5187, 5133, 5177; we define Life Science as 3254, 3391, and 5417; we define retail as 42, 44, 45; we define manufacturing as all the codes contained in 31, 32, and 33 that are not already included in IT and Life Science. Lastly, the group Others is a residual group.

represented by copyrights. Not surprisingly, in this case IT is the leader in terms of importance with 58.6% of the firms reporting copyrights as at least somewhat important, followed now by Life Science (50.4%), retail (37.6%), manufacturing (37.1%), and lastly other firms (24.9%).[15]

Altogether, industry variation explains a great deal of differences in the important of IP protection across firms. While all IP protection mechanisms are generally important for high-tech firms, the opposite is true outside. For other manufacturing firms and companies in retail, the protection of IP is perceived as a second-order problem, with a very low reported importance of all the IP tools. Across all sub-samples, the group of firms in the "other" category ranks very low in both absolute and relative terms. In Section 4, we return to this point and better quantify the importance of industry effects in explaining variation in IP use.

Second, the relative ranking across different forms of IP protection remains stable across industries. In particular, utility patents are never the main form of IP protection reported by firms. Across every industry, utility patents are always ranked after trade secrets. Except for firms in Life Science, utility patents are also perceived as less important than trademark and copyrights. These results suggest that, while there is a level difference across industries, the relative importance of different forms of protection is fairly stable.

3.4 Importance of IP Does not Change as Firms Age

We now examine whether the stated importance of IP protection varies over the life cycle of firms. While our data does not allow us to systematically follow the same firm over time, the sample covers a very wide range of firms at different points the firm-age distribution. Thus, we can examine whether firm age explains a significant amount of variation in IP importance and behavior.

To address this question, we divide our sample in five groups based on the company's age constructed from the LBD. In particular, the group of younger firms (group 0) contains companies still at the start-up phase (0-2 years), while the group of older firms (group 4) contains firms that have been active for over three decades.[16] Using these categories, we then replicate the same

[15] Another less notable exception is design patents, where other manufacturing firms report roughly the same level of importance as IT and Life Science.

[16] The five groups are defined as followed: (1) 0-2 years; (2) 3-9 years; (3) 10-19 years; (4) 20-29 years; (5) 30+ years.

examination of the importance of different forms of IP protection splitting across these groups. The results are reported in Figure 6.

Across the various dimensions, we consistently find little or no difference between firms of different age: older firms do not systematically differ from younger firms across any of the considered dimensions. For instance, looking at patents 24.7% of start-ups in the data reports that patents are very important, and the same statistic is 25.2% for the older group of firms. With some small variation across different sub-groups, the same similarities old across the rest of analyses.

In Figure 7 we confirm the same finding using a regression analysis. This analysis also allows us to address two potential concerns with this lack of differences between age groups. First, firm entry and average life could be different between industries, and this may be an important confounding factor in our setting. To address this issue, this analysis includes narrow industry fixed effect (4-digit NAICS) interacted with year dummies so we can compare the importance of age within industry-year pairs. Second, the lack of response in the self-reported measures may reflect some differences in reporting errors in self-reported measures across age groups. We deal with this potential issue by focusing on patents, and reporting the same results with both the self-reported measure as well as the two measures based on patenting (i.e. intensive and extensive margin). Figure 7 reports the coefficient on the different age groups, normalizing the coefficient for the youngest group of firms to zero.[17]

The results generally confirm the previous observations. Across both the self-reported measure and actual patenting behavior, we fail to identify any consistent relationship between age and patent importance. While some coefficients are statistically different from zero, the magnitudes of the effects are generally small and more importantly there is no consistency across outcomes and groups, making it hard to identify any pattern in the data.

Altogether, differences in age do not explain a lot of the variation in IP activity between firms, both in absolute and relative terms. In Section 4, we will come back to discuss this result and try to attempt to explain it within the context of the literature.

[17] We estimate this analysis on a sample of about 53 thousand firms reporting positive R&D in the year, since we need positive R&D spending to construct the patent intensity measure. We cluster standard errors by firm to account for the fact that some firms are sampled multiple times in the sample.

3.5 Larger firms are systematically more active in IP protection, across all forms of protection

Using the same empirical strategy as above, we now examine whether differences in firm-size explain the variation in the importance of IP protection. We divide firms into five groups based on worldwide sales. The group containing the smallest firms has sales below $10 million (group 0) while the group with largest firms (group 4) has over $1 billion in sales.[18] We then repeat the same analyses as we have done for age, splitting the responses to the IP questions across these sub-groups.

The results are reported in Figure 8. Size appears to have a very clear effect on the overall IP importance. Across all the measures considered, we find that larger firms report higher importance for each form of IP protection, and the increase appears to be monotonic in the size groups. To gauge the magnitude of these differences, it is useful to compare a few metrics between the smallest and largest firm-size groups. For instance, 69% of the largest firms consider patents to be important (either very or somewhat) but this percentage is only around a third (24% of firms) for the group containing the smallest firms.

This positive relationship between size and the importance of IP is not to patents. In general, similar effects can be identified for all of the other types of IP protection included in BRDIS, with similar magnitude across categories. This evidence suggests that IP protection is increasingly important for larger firms, and this effect holds across all types of protection examined.

At this point, there are two extra results that we would like to point out. First, as for the age effects, we can also replicate the same effects in a regression framework where we also control for both industry-by-time fixed effects and explore the robustness of this effect when looking at actual behavior (Figure 9). We will discuss more these regressions analyses in Section 4, but for now we simply want to point out that these size effects are robust to the inclusion of industry-by-year fixed effects, controls for firm age, and R&D intensity.

Second, the importance of size in explaining IP protection is clear when examining how differences across industries hold between larger and smaller firms. In the two panels of Figure

[18] The group construction is the following: (1) 0-10 million; (2) 10-25 million; (3) 25-100 million; (4) 100-1000 million; (5) 1000+ million. All values are in US dollars nominal terms.

10, we replicate the analysis of different IP importance across industries, but now splitting the sample between firms above and below $100 million in worldwide sales. For smaller firms (top panel), we find a pattern that is exactly the same as the one identified in the full sample (Figure 5). The only significant difference is that the level of IP importance across all measures is generally lower, consistent with the finding that smaller firms care less about IP overall.

For large firms, the pattern changes significantly. Beyond showing a general increase in the importance of IP for larger firms, we also document a sizable reduction in dispersion across industry. In general, the gap between high-tech industries, retail, and manufacturing is substantially lower for larger firms than for the overall population. Looking at patents, we find that 77.6% of firms in Life Science think that patents are important (either very or somewhat), and this is higher than the same percentage for IT (67.4%), but by a smaller margin than before. Even more interesting manufacturing (65.75%) and retail (56.1%) are also much closer in terms of reported importance. For comparison, among smaller firms, utility patent importance in Life Science (69%) is more than three times higher than retail (22%), while here the gap is only a 27%. The dispersion between industries is even smaller for non-patent categories: for instance, 84.4% of large Life Science firms report trade secrets to be important, and this is very close to the same statistics for IT (80.1%), manufacturing (80.5%), and even retail (71.1%). The residual category of firms in other industries appear an exception to this behavior, as we keep finding relatively small differences in size.

Overall, the descriptive evidence suggests that the management of IP is significantly different across smaller versus larger firms, with the latter group being more active across all fronts. Furthermore, at least in part, size appears to trump differences between industries, confirming the economic importance of this dimension.

4 The Role of Size and Age

This section explores the findings about age and size in in more detail, and provides some informed speculation about potential causes.

4.1 IP and Firm Age

As described above, we find no clear relationship between age and intellectual property strategies. That is, firm age does not appear to play an important role in determining how firms use various forms of IP. This result holds across different analyses: for instance, the regression analysis suggests that this result does not simply capture differences across industries. At first sight, this result may appear surprising, since various theories would suggest a connection between IP strategies and age. For instance, younger firms may lack alternative appropriability mechanisms to protect new products or technologies, and might therefore be more reliant on legal protections.

Although age does not seem to predict reliance on IP, it is possible that after conditioning age, IP use predicts firm level outcomes. For example, Guzman and Stern (2015) measures various actions taken in the early life of an entrepreneurial company (e.g. patenting, trademark, corporate registrations) and find that these actions are informative regarding future growth. This suggests that firms may not pursue of a specific type of IP strategy as a result of changes in the business conditions (e.g. inventing a new product), but rather as a pre-determined choice that the firm makes at founding based on expected future opportunities. Following a similar approach, we can examine whether differences in the use of IP early in the life of a firm systematically predicts its future behavior.[19] To the extent that the lack of differences in IP over the life cycle reflects the fact that these decisions are forward-looking, we should expect that initial use of IP explains future growth of the firm. We implement this test by looking at a sample of firms that answered our survey in the first year of life and we examine whether their future growth is impacted by their initial decision regarding conducting R&D activity and patenting.[20]

The findings of this analysis are reported in Table 1. We divide the sample into three groups: firms without R&D and patenting (omitted category), firms only doing R&D but without patents, and firms that are doing both R&D and patent, and we test whether these firms differ in terms of economic success, always controlling for industry-by-year fixed effects.[21] The results show that firms conducting R&D and patenting start larger and experience significantly higher employment growth than firms that perform R&D without patenting, which in turn are larger and aster growing

[19] Since most of the firms in our data are surveyed only once in the period covered (and this is particularly true for younger firms), we cannot directly test whether there is persistence in the reported importance of IP in our sample.
[20] To be specific, we only consider firms that answer the survey in year 0 or 1 and that have less than 50 employees in the survey year.
[21] We conduct this analysis by matching our sample with the LBD to recover firm level employment in year five of the firm life. The act of conducting R&D and patent is defined consistently with the previous analyses in the paper.

than the control group. This evidence confirms that the initial decision to patent contains significant information about the future behavior of firms.

Irrespective from the specific channel explaining this lack of differences over the life cycle, this evidence is informative for innovation policy. In recent years, research in entrepreneurship highlighted the risks of introducing policies that focus on a generic definition of "young firms," which distinguishing between those with the potential to become high growth companies (i.e. gazelle) and the rest. On a similar note, this analysis shows that age *per se* does not necessarily tell us a lot about how a company uses IP, suggesting that this variable in isolation may not provide useful information for policy makers.

4.2 IP and Firm Size

Another clear finding above is the strong connection between size and the importance of intellectual property. Unlike age, size systematically correlates with the use of IP: larger firms report all forms of IP to be relatively more important. The relationship appears to be monotonic, and it is not driven by a specific point of the size distribution. Furthermore, the same result also holds when examining actual behavior in patenting. As we show in Figure 9, this result also holds in a regression framework where we control for industry-by-year fixed effects as well as when we augment this specification for differences in age between firms and R&D intensity.[22]

There are several possible interpretations for the robust relationship between size and IP importance. A baseline explanation is that this increasing importance of IP for larger firms is exactly what we should expect given the nature of intellectual property (e.g. Argente et al., 2020, Crouzet and Eberly, 2019, Haskel and Westlake, 2017). In general, investments in IP should not be characterized by decreasing returns to scale. For instance, the value of the patent should be (at least) scalable as the firm's size grows, and a similar argument can be made for the other forms of IP protection discussed earlier (i.e. copyrights, trade secrets, trademarks). In this context, it is natural to expect that IP to be relatively more important for larger firms.

However, larger firms may differ from smaller firms on a variety of dimensions. This makes it hard to disentangle the previous explanation from alternatives. In principle, any factor that

[22] We control by age by including the five dummies dividing firms based on age that were discussed earlier. We control for R&D intensity by measuring the amount of R&D performed scaled by sales worldwide.

systematically differs across firm size and also explains the use of IP may explain the relationship found in the data. While excluding all possible alternative stories is beyond the scope of this study, we can use the richness of our data to exclude some leading alternative interpretations. On top of the variables already discussed (i.e. industry, age and R&D intensity), we examine a variety of firm characteristics that are plausibly correlated with firm size and that may also explain their IP behavior.

First, we construct a proxy for the use of the market for technologies, under the assumption that larger firms may be more active in the market for technology, and also care relatively more about intellectual property. We specifically construct two dummy variables, one measuring firms that have used M&A to acquire IPs and one that specifically identifies firms that have been active in IP transfers.[23] Second, we control for the firm's investment in different type of R&D activities, in particular distinguishing R&D spent for basic research, applied research, and development.[24] In principle, firms of different size may tend to specialize more on some activities, and this specialization may shape their IP strategies. Third, we also include variables that measure the type of innovation that the firm has produced. In our data, firms are asked to report their innovation across different dimensions (e.g. product, process, logistics,…). Different types of innovation --- for instance product versus process --- may require different types of IP protection, and therefore influence the behavior of the firm.[25] Lastly, we also control for the presence a specialized IP office in the firm. The management of IP may be characterized by a sizable fixed-cost component. To the extent that larger firms are more likely to have an internal IP department, this dimension may explain a large part of the variation.[26]

[23] The M&A IP dummy is equal to one if the firm received any IP by a spinoff, acquired a company for its IP, or acquired financial interest in a company for its IP. The Transfer IP dummy is instead equal to one if the firm has transferred IP to others directly, transfer IP though a spin-off, or have been engaged in cross-licensing. These variables are measured in the year of the survey.

[24] We essentially include control for the share of R&D that is spent in development, and share of R&D spent in basic research. The residual omitted portion is R&D spent for applied research.

[25] We specifically can control for innovation that improved goods, services, methods, logistics, and support activities. Each of these measures is measured through a specific dummy variable in the model.

[26] We use patent data to construct a variable which is equal to one if the firm is likely to have an internal IP. We link the patent data to the list of lawyers. Within the official patent lawyers, we identify those that are working directly for a firm by fuzzy match the name of the institution for which the lawyer works and the firm name. We then define a firm to have internal IP office if the firm received at least a patent in the period considered that was filed by a lawyer working for the firm. As expected, we find that the presence of an internal IP is largely concentrated in larger firms.

We then use our regression framework to test how our results change as we include these variables as controls. The output is provided in Figure 11, and in every specification, we always include industry-by-time fixed effects, R&D intensity, and age controls. Across all combinations of controls examined and the outcomes considered, we find an economically significant positive relationship between IP importance and size. While the inclusion of controls in some cases affect the relative magnitude, the basic relationship remains economically and statically significant.

This analysis highlights how the positive relationship between firm size and IP does not simply reflect routine observable differences in the nature of R&D or the innovation process. In particular, our finding does not appear to capture differences in industry, firm age, R&D intensity and composition, innovative output, importance for the market for technologies, and the presence of a specialized IP office. While this list is not comprehensive – there might be unobserved differences between large and small firm innovation processes that drive the importance of IP – the results do suggest a strong role for scale *per se*.

There are two other findings that are relevant to understanding the importance of firm size in explaining the importance of IP. First, firms of different size do not only appear to significantly differ in the way they protect their intellectual property, but firm size in general is quantitatively important to understand cross-sectionally differences in the use of IP. To examine this dimension, we implement an R-Squared decomposition, which exploits the logic of Shapley values to estimate the relative share of variance that is explained by different groups of variables (Huettner and Sunder, 2012).[27] Table 2 presents the results by reporting always the share of variance explained by industry, year, and size categories but also including one at the time the other dimensions that were discussed earlier (i.e. age, R&D intensity, etc…). We conduct this analysis on the self-reported importance of patents, patenting probability, and patenting intensity.

In general, these results suggest that the size groups explain a significant share of the variance across all outcomes. If we look at the self-reported importance of patents (columns 1, 4, 7, 10, 13, 16, 19), we find that the size groups explain between 26% and 43% of the variance. Furthermore, this dimension appears to be the most important one, possibly together with industry. For this

[27] We implement this model using the command "rego" in Stata and using the same sample and variable definitions as the previous analyses. For computational reasons, our definition of industry in this analysis is broader and based on the two-digit classification. For the same reason, we also cannot include all variables at once but only sub-group by sub-group.

outcome, in the one-to-one comparisons, the share explained by the size groups is higher than any other dimensions considered, with the exception of factors measuring the market for technology. Size generally explains more variance when looking at actual patenting behavior at the extensive margin (i.e. "Any Patent"), and less when looking at patent intensity. Even in the latter case, however, size plays a significant role in explaining variation in the importance of IP.

Second, the relationship between size and patenting importance holds even for firms that do not conduct R&D. In Table 3, we replicate the same regression analysis focusing only on those firms without any R&D in the year of the survey.[28] The findings are consistent with those generated on R&D sample: larger firms tend on average to report higher importance of patents and also show a similar response in terms of behavior. This evidence suggests that the importance of IP for companies may encompass the simple need of protecting the output of R&D activity.

Altogether, firm size is an important variable when studying how firms use IP. On average, larger firms are more likely to self-report that various forms of IP protections --- and in particular patents --- are more important, and the same results hold for actual patenting behavior. This difference in behavior is not explained by observable differences across firms in industry, age, R&D investments, or innovative output. Furthermore, this effect holds on separately for both R&D and non-R&D firms, and it appears to explain a significant share of the cross-sectional of IP activities by firms.

5 Conclusion

This paper exploits novel Census data to revisit an old, but important question: how do US firms use intellectual property protection? Our analysis focuses on documenting a novel set of stylized facts. First, while patenting per se is relatively uncommon in the economy, patenting firms are those performing more than 90% of US R&D. Second, across firms, utility patents play a relatively small role. The majority of the firms report utility patents as not important. In relative terms, trade secrets, copyrights, and to some extent trademarks are systematically reported as more important than patents. Third, industry differences play an important role in understanding the use of IP. In general, high-tech industries (Computer and Life Science) tend to care about all IP strategies with

[28]This sample contains roughly 47,500 observations. Since these firms always have zero R&D, we cannot examine our measure of patent intensity for this group.

respect to the rest of the manufacturing sector, retailers, and other firms. However, the relative ranking of different forms of protection remains generally unaltered also across industries.

Fourth, our results also highlight how age per se does not appear to play an important role in mediating the importance of IP. In general, there is no systematic relationship between age and IP, both in absolute level (i.e. older firms do not care more about patents than younger ones) and across IP strategies (e.g. patents vs. trade secret). Fifth, unlike age, firms of different size appear to behave significantly differently on their use of IP. On average, larger firms tend to value much more IP strategies. This result also holds for both R&D and non-R&D firms separately, and this relationship remains significant and large also when adjusting for differences across firms in R&D spending and innovation activities.

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Figures

Figure 1. Patenting Behaviors of Firm Along Extensive and Intensive Margin

The two panels in this figure plots the mean of two measures of patenting behavior by the firm's response to the qualitative question: how important for your company were there utility patents? In the first panel (left), the variable used to proxy patenting behavior is a dummy variable equal to one if the firm has applied to any panel in the 5-year window around the considered year in the survey. In the second panel (right), the variable used to measure patenting behavior is the ratio between the count of patents in same window as before scaled by R&D.

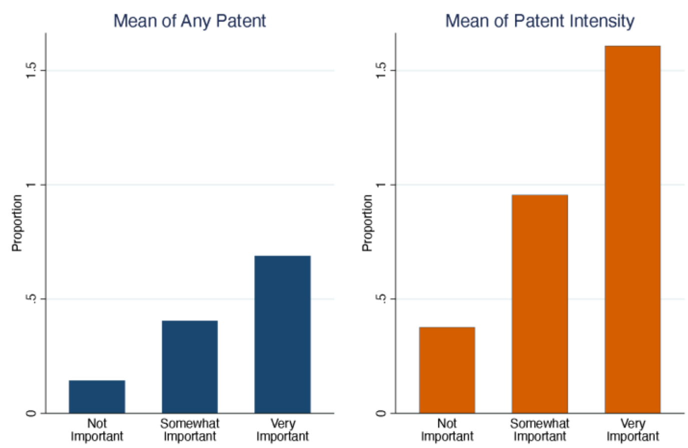


Figure 2. Composition of Firms by Patenting Activities and R&D Spending

This pie chart reports the (unweighted) share of firms in the data used split based on whether the firm is conducting R&D in the year of the survey and whether the firm is labelled as patenting firm, following the usual definition.

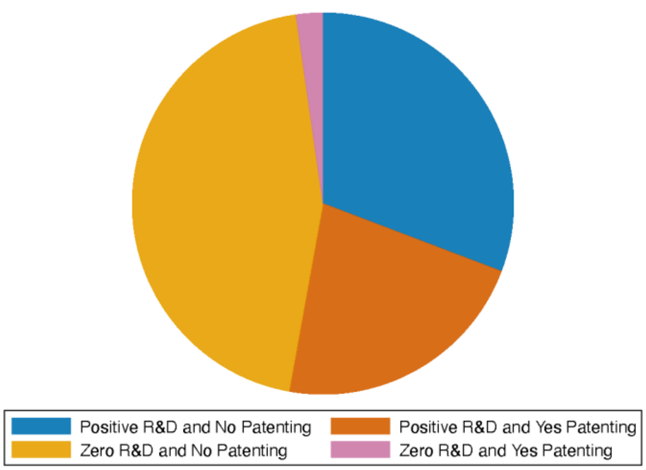


Figure 3. R&D Spending for Patenting and Non-Patenting Firms in the United States

This pie chart plots the share of R&D split between firms that patent and that do not patent, following the usual definition.

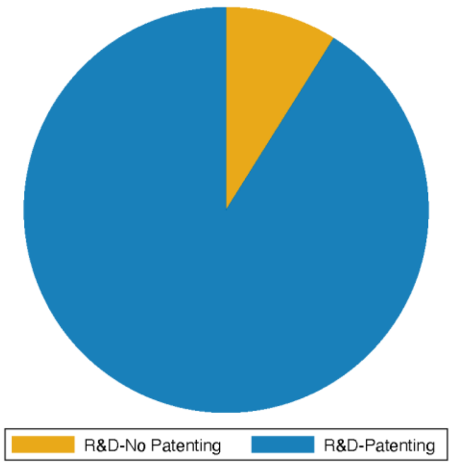


Figure 4. Importance of Different IP Protection Strategies, All Firms

This bar graph reports the share of response by firm to the question: During this past year, how important to your company were the following types of intellectual property protection? This example question is modelled on the 2008 version. We consider five types of protections: patents, trade secrets, copyrights, trademark, and design patents.

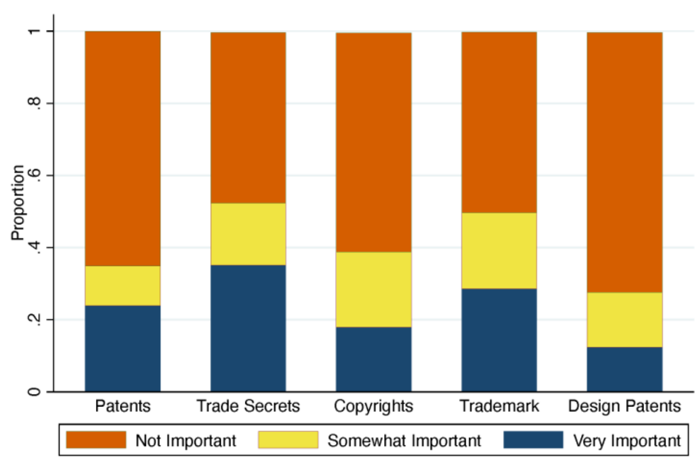


Figure 5. Importance of Different IP Protection Strategies by Industry

This set of bar graphs reports the share of response by firm to the question: During this past year, how important to your company were the following types of intellectual property protection? This example question is modelled on the 2008 version. We consider five types of protections: patents, trade secrets, copyrights, trademark, and design patents. Each panel focuses on a different form of protection and reports the share of responses in each category by macro industry classification. In particular, we split the sample in Life Science, IT, Manufacturing, Retail, and others (residual category).

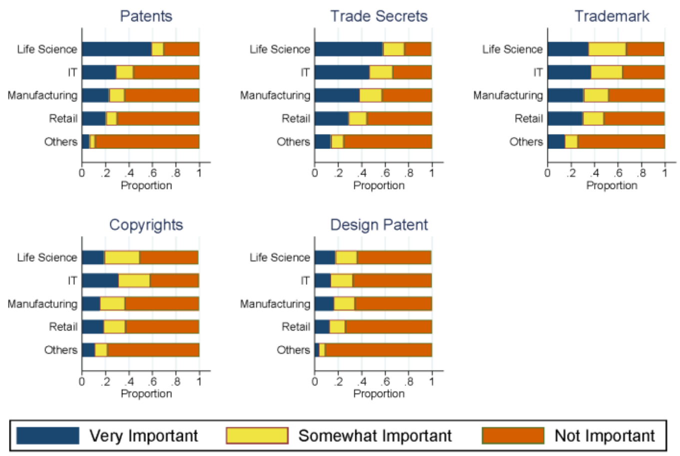


Figure 6. Importance of Different IP Protection Strategies by Firm Age Group

This set of bar graphs reports the share of response by firm to the question: During this past year, how important to your company were the following types of intellectual property protection? This example question is modelled on the 2008 version. We consider five types of protections: patents, trade secrets, copyrights, trademark, and design patents. Each panel focuses on a different form of protection and reports the share of responses in each category by groups of firm age. The five groups are defined as followed: (0) 0-2 years; (1) 3-9 years; (2) 10-19 years; (3) 20-29 years; (4) 30+ years.

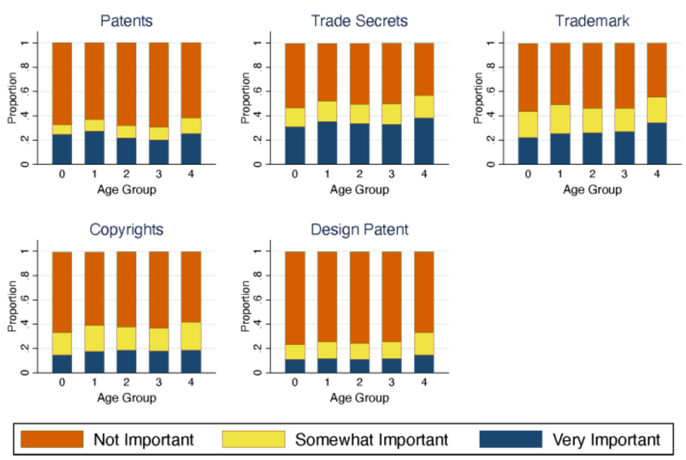


Figure 7. Estimates on Patent Importance, Intensity, or Patenting Status by Firm Age Group

These figures report the output of a regression model where we examine how age affects different proxy for importance of patent. In each case, the figure reports the coefficients on the effect of age for each group (i.e. (0) 0-2 years; (1) 3-9 years; (2) 10-19 years; (3) 20-29 years; (4) 30+ years). The group zero is the reference group. Each specification also includes industry (4-digit NAICS) by time (year) fixed effects. The figure also reports the 95% confidence interval around the coefficient. The outcomes used are the self-reported measure of patent importance (i.e. dummy equal to one if the firm reported patents to be important or very important), patent intensity (i.e. patent count over R&D), and the variable any patent (i.e. dummy equal to one if the firm applied to any patent around the survey year). Standard errors are clustered at firm-level.

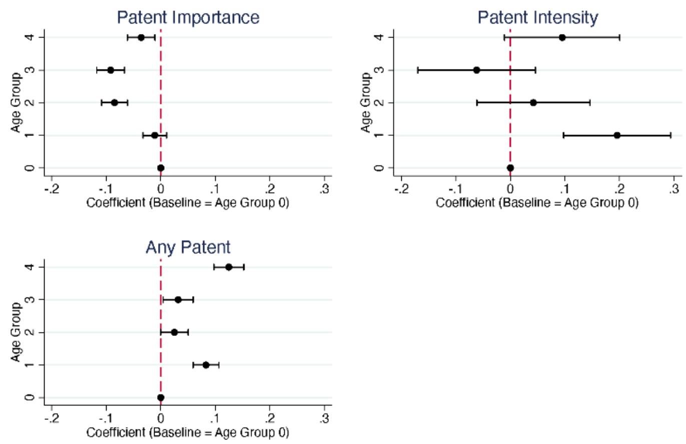


Figure 8. Importance of Different IP Protection Strategies by Firm Size Group

This set of bar graphs reports the share of response by firm to the question: During this past year, how important to your company were the following types of intellectual property protection? This example question is modelled on the 2008 version. We consider five types of protections: patents, trade secrets, copyrights, trademark, and design patents. Each panel focuses on a different form of protection and reports the share of responses in each category by groups of firm size (using worldwide sales as proxy). The five groups are defined as followed: (0) 0-10 million; (1) 10-25 million; (2) 25-100 million; (3) 100-1000 million; (4) 1000+ million. All values are in US dollars nominal terms.

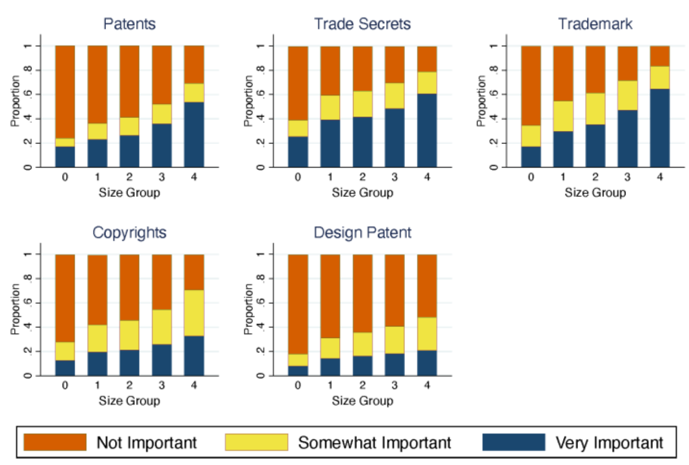


Figure 9. Estimates on Differences in Patent Importance, Intensity, or Patenting Status by Firm Size Group

These figures report the output of a regression model where we examine how size affects different proxy for importance of patent. In each case, the figure reports the coefficients on the effect of age for each group (i.e. (0) 0-10 million; (1) 10-25 million; (2) 25-100 million; (3) 100-1000 million; (4) 1000+ million.). The group zero is the reference group. The figure also reports the 95% confidence interval around the coefficient. The outcomes used are the self-reported measure of patent importance (i.e. dummy equal to one if the firm reported patents to be important or very important), patent intensity (i.e. patent count over R&D), and the variable any patent (i.e. dummy equal to one if the firm applied to any patent around the survey year). The black dots report the results when only (4-digit NAICS) by time (year) fixed effects are included. The blue square reports the result when also age dummies are included on top of the industry by year fixed effects. The red triangle reports the results when we also control for R&D intensity, on top of the age and industry by year effects. Standard errors are clustered at firm-level.

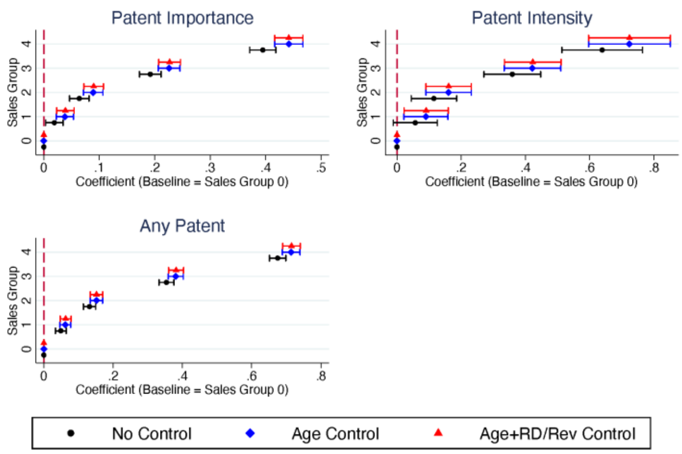


Figure 10. Importance of Different IP Protection Strategies by Industry for Large and Small Firms

This set of bar graphs reports the share of response by firm to the question: During this past year, how important to your company were the following types of intellectual property protection? This example question is modelled on the 2008 version. We consider five types of protections: patents, trade secrets, copyrights, trademark, and design patents. Each panel focuses on a different form of protection and reports the share of responses in each category by macro industry classification. In particular, we split the sample in Life Science, IT, Manufacturing, Retail, and others (residual category). The top graph reports the results for those firms that have less than $100 in sales. The bottom graph reports the same results for larger firms (higher than $100M in sales).

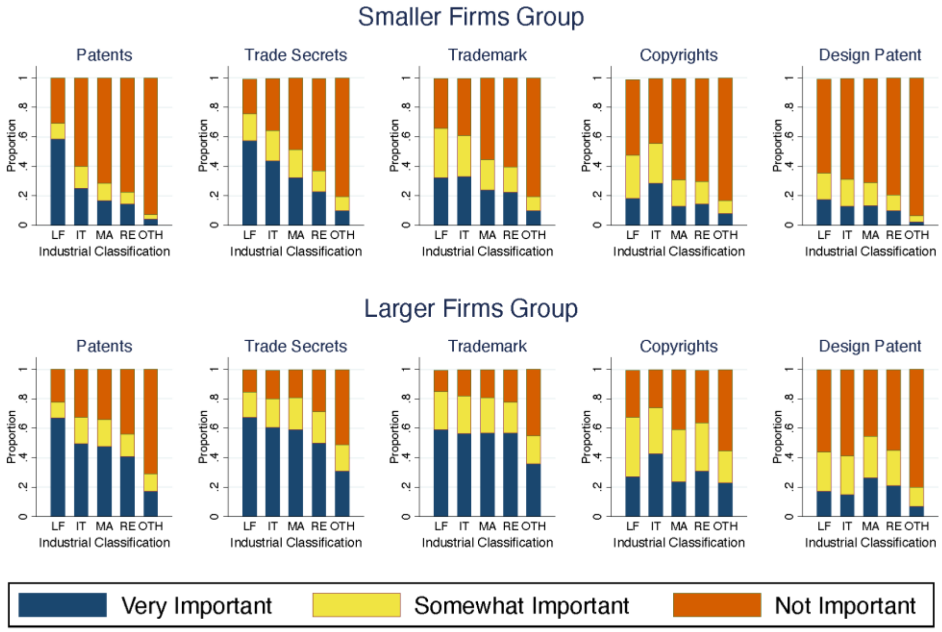
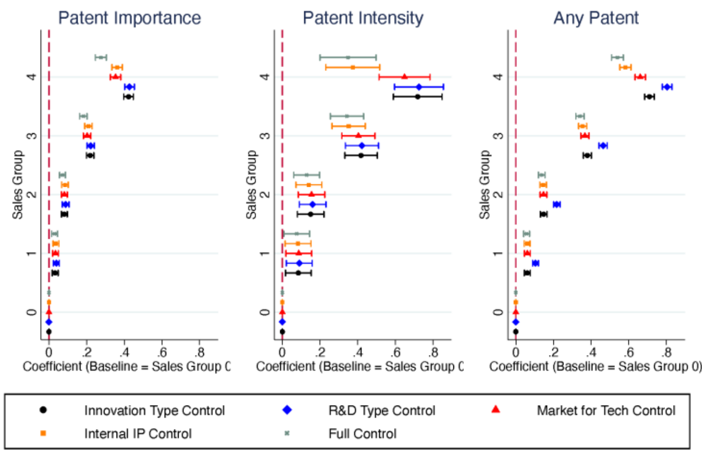


Figure 11. Estimates on Differences in Patent Importance, Intensity, or Patenting Status by Sales Group

These figures report the output of a regression model where we examine how size affects different proxy for importance of patent. In each case, the figure reports the coefficients on the effect of age for each group (i.e. (0) 0-10 million; (1) 10-25 million; (2) 25-100 million; (3) 100-1000 million; (4) 1000+ million.). The group zero is the reference group. The figure also reports the 95% confidence interval around the coefficient. The outcomes used are the self-reported measure of patent importance (i.e. dummy equal to one if the firm reported patents to be important or very important), patent intensity (i.e. patent count over R&D), and the variable any patent (i.e. dummy equal to one if the firm applied to any patent around the survey year). In each specification, we always include the (4-digit NAICS) by time (year) fixed effects, age controls, and R&D intensity controls. The different versions plotted, then report the effects as we include different types of control (as labeled). Notice that we also include one version where all controls are included together. Standard errors are clustered at firm-level.



Tables

Table 1. IP and R&D at Birth and Future Performance

This Table reports the results from a cross-sectional regression where we predict future growth with the responses of firms in the early part of its life. The sample contains all firms surveyed in the first two years of life by the BRDIS, which were also be able to match with LBD. The omitted group in the regression is the set of firms that did not do any R&D and did not patent early in life. At the bottom of the table, we also report the F-statistic for the difference between the two reported groups (R&D and patents versus R&D and no patents). Each specification includes industry (4-digit NAICS) by time (year) fixed effects. Heteroskedasticity-robust errors are provided in parenthesis.

	1{Active}	Ln(# Empl.+1)	Growth Emp (5yr)
R&D & Patent	0.037	0.507***	0.375***
	(0.058)	(0.126)	(0.087)
R&D & No Patent	-0.067	0.174**	0.161***
	(0.043)	(0.075)	(0.057)
Industry-Year FE			
r2	0.42	0.824	0.843
N	2000	2000	2000
Robust Errors			
F-statistics for the difference between “R&D & Patent” and “R&D & No Pat”	4.2	8.94	7.19

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 2. Variance Decomposition

This Table reports the variance decomposition generated using the Shapley Value approach as in Huettner and Sunder (2012). Essentially, each column reports the share of the variance explained of the outcome by the characteristics reported in the first column. This decomposition is conducted by variable "group" rather than single variable. Each column should sum to 100 (net of rounding following the disclosure process). The analysis examines three outcomes, in line with the regression models. Across each column, we consider different combination of controls. We always include the year, industry fixed effects (2-digit NAICS), and size groups.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Variables	**1{Pat. Import.}**	**Pat. Intensity**	**1{Any Pat.}**	**1{Pat. Import.}**	**Pat. Intensity**	**1{Any Pat.}**	**1{Pat. Import.}**	**Pat. Intensity**	**1{Any Pat.}**	**1{Pat. Import.}**	**Pat. Intensity**	**1{Any Pat.}**
Size Groups	43.43	10.41	73.52	41.18	10.09	70.19	43.22	10.41	73.3	26.33	8.39	60.08
Industry	41.36	45.54	20.14	35.49	44.11	18.48	41.09	45.52	20.04	30.8	43.98	17.83
Year	15.22	44.04	6.33	12.53	41.96	5.83	15.08	44.03	6.3	12.06	42.74	5.77
Age Groups				13.23	3.82	5.48						
R&D Intensity							0.62	0.029	0.35			
Market for technology										30.81	4.88	16.31
Innovation Type												
Type of R&D spending												
Internal IP Office												

	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)
Variables	**1{Pat. Import.}**	**Pat. Intensity**	**1{Any Pat.}**	**1{Pat. Import.}**	**Pat. Intensity**	**1{Any Pat.}**	**1{Pat. Import.}**	**Pat. Intensity**	**1{Any Pat.}**
Size Groups	34.64	8.97	68.68	38.39	10.28	69.42	28.24	5.28	47.7
Industry	34.07	35.86	19.09	38.12	45.41	19.21	34.13	36.05	15.05
Year	13.05	38.22	5.99	13.64	43.97	6.12	12.65	36.9	5.03
Age Groups									
R&D Intensity									
Market for technology									
Innovation Type	18.23	16.94	6.23						
Type of R&D spending				9.83	0.33	5.25			
Internal IP Office							24.97	25.21	32.21

Table 3. Patent Importance and Size, non-R&D firms

This table reports the output of a regression model where we examine how size affects different proxy for importance of patent. Unlike before, we only focus on firms without any R&D investment. In each case, the figure reports the coefficients on the effect of age for each group (i.e. (0) 0-10 million; (1) 10-25 million; (2) 25-100 million; (3) 100-1000 million; (4) 1000+ million.). The group zero is the reference group. The outcomes used are the self-reported measure of patent importance (i.e. dummy equal to one if the firm reported patents to be important or very important) and the variable any patent (i.e. dummy equal to one if the firm applied to any patent around the survey year).We always include industry (4-digit NAICS) by time (year) fixed effects, and in even columns we also include control for age, using the same group as defined in the rest of the analysis. We cannot do this analysis for patent intensity since R&D is always zero for these firms. Standard errors are clustered at firm-level.

	1{Pat. Import.}	**1{Pat. Import.}**	**1{Any Pat.}**	**1{Any Pat.}**
Size Group 1	0.029***	0.031***	0.024***	0.023***
	(0.004)	(0.004)	(0.003)	(0.003)
Size Group 2	0.040***	0.043***	0.055***	0.054***
	(0.005)	(0.005)	(0.004)	(0.004)
Size Group 3	0.070***	0.075***	0.130***	0.128***
	(0.007)	(0.007)	(0.008)	(0.008)
Size Group 4	0.162***	0.171***	0.405***	0.401***
	(0.015)	(0.015)	(0.019)	(0.019)
Age	No	Yes	No	Yes
Industry-Year FE	Yes	Yes	Yes	Yes
r2	0.097	0.098	0.181	0.181
N	47500	47500	47500	47500

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1